DESIGN OF OBSTACLE AVOIDANCE ROBOT

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ABSTRACT

Recently, there are many types of robots available in market, either in form of pets, toys, cleaners and etc. Robots are utilized in many applications to assist human-being. The purpose of this project is to develop an autonomous robot that can move by itself without continuous human guidance. This robot will be controlled using the SK40C controller board that used an infrared sensor, microcontroller PIC 18F4550 and also a dc geared motor and a 16x2 LCD screen. When the robot is on, the LCD screen will show "Avoidance robot ON" and the buzzer will sound a beep continued by a move forward. When it senses an obstacle in front, it will reverse and then either turn left or right depending on the left sensor or right sensor that detect the obstacle then it will continue to move forward. When it senses an obstacle at the left, the LCD screen will show "Obstacle at front, reversing", then followed by "Turn right, move forward". As a result, this robot is useful as a baby walker to avoid the baby walker from hitting thing that may cause harm to the baby.

ABSTRAK

Sejak kebelakangan ini, terdapat banyak jenis robot yang boleh didapat di pasaran, sama ada dalam bentuk haiwan peliharaan ,mainan, pembersih,robot dan sebagainya telah digunakan dalam pelbagai kegunaan untuk membantu manusia. Tujuan projek ini adalah untuk membina sebuah robot yang boleh bergerak sendiri tanpa bimbingan manusia yang berterusan. SK40C akan digunakan dalam robot ini , penderia inframerah, microcontroller PIC18F4550 ,dc motor dan juga skrin LCD akan digunakan. Apabila robot dinyalakan "Autonomous Robot ON" akan ditunjuk pada skrin LCD dan bunyi beep akan keluar dan juga robot akan mula gerak ke hadapan. Apabila halangan di kesan dihadapan , ia akan berundur kemudian sama ada belok kiri atau ke kanan bergantung sensor mana yang mengesan halangan di depan.Apabila halangan pada sebelah kiri ,LCD screen akan menunjukan "Halangan di kiri,berundur", kemudian diikuti dengan "belok kanan"dan bergerak ke hadapan.Robot ini adalah berguna jika digunakan pada kerusi roda bayi, ia boleh menghalang bayi daripada mengelak pada hanlangan yang munkin bahayakan keselamatan bayi.

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LIST OF ABBREVIATIONS

PIC	**Programmable interface Controller**
IC	**Integrated circuit**
V	**Volt**
dc	**Direct current**
I/O	**Input/Output**
A	**Ampere**
IR	**Infrared**
cm	**Centimeter**
ADC	**Analog To Digital converter**
LCD	**Liquid Crystal Display**
PM	**Permanent Magnet**
DC	**Direct Current**
RPM	**Revolutions per minute**

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CHAPTER1

INTRODUCTION

1.1 BACKGROUND

The term "robot" was introduced by Chzexh dramatists Joseph Capek in his brother KarelCapek play Rossum's Universal Robots in 1921. The word robot comes from the Czech word "robota" meaning "labor". Later, in 1942, Issac Asimov built upon Capek's ideas and defined the term "robotics" and outlined the three rules of robotics in his books that is may not injure must obey the orders must obey the orders. In Europe ,robotics is defined as the science of robotology and the robotology is defined as the meaning of putting the robot machines together and to do work. [1,2]

Autonomous robots are robots that can perform desired tasks in unstructured environments without continuous human guidance. Many kinds of robots have some degree of autonomy. Different robots can be autonomous in different ways. A high degree of autonomy is particularly desirable in fields such as space exploration, cleaning floors, mowing lawns, and waste water treatment.

For humans, the ability to navigate our thinking movement is controlling using our brains. But for mobile robotic systems, navigation in dynamic real-world environments is an extremely complex and challenging task. Complex structure and the movement of robot is more harder depend to its complexity of design, mostly the design of movement of robot is copying from human motion activity and some are copy from animals or insects such as spider.

Autonomous robot has the ability to gain information about the environment, work for an extended period without human intervention, move either all or part of itself throughout its operating environment without human assistance ,and can avoid situations that are harmful to people, property, or itself.

Before the autonomous robot was invented, there were only ordinary robots. These robots were depending on human control. These robots did not have any self avoiding system toward obstacles; all is totally control by human. Therefore to over comes those problems, the autonomous robot were invented to replace human in doing dirty, difficult and *dangerous* work such as denoting the bombs.

Therefore,this project is to develop an autonomous robot that can move to the destination without geting block by obstacles and can show the information to LCD screen .The basic concept of this project is to design a robot that can move forward and backward without human guidance.The PIC controller will be used as the "brain" of the robot to control its system.The infrared sensor will be using as the guidence to track the obstacles that block the path.

1.2 PROBLEM STATEMENT

An important problem that a navigating robot is facing in a crowded environment is that the robot can be easily get blocked by moving humans and obstacles. In such cases, the robot becomes immobilized and not able to continue its movement towards its goal position until the moving obstacles and humans free from its way. To avoid ever getting in such a situation, many researchers have tried to predict the motion of humans and obstacles. The future motion prediction of humans and obstacles allows the robot to estimate if the way it follows is going to be blocked and thus change direction before it ever faces this situation.

Future motion prediction is an intrinsic behavior of humans. Consider the example of a man trying to cross a street. A man looks at his left and right to see if any vehicles are approaching. If there are no vehicles he is certain that he can cross the street safely and so he does. In the case that a vehicle is approaching, he tries to estimate

how long it will take for the vehicle to reach the point that he stands and then decides if he should cross the street. This is in effect a predictive behavior. It would be desirable for an autonomous robot to develop a similar behavior.

1.3 OBJECTIVE

The objective of this project is to:

1) To develop an obstacle robot that can move it-self without continuous human guidance by using PIC controller as the "brain" of robot to operate.

PIC18F8550 will be use as controller in this project. So by programming the controller the movement of the robot can be predicted using programming.

2) To perform detection of obstacles using Infra-red sensors and will be giving respond from PIC controller to change robot path.

Infrared sensor will be installed on the robot .By using the sensor when the robot is near to the obstacle, the signal will be sent to microcontroller to let the controller decide the step/process should be taken ,to change to which direction.L293D motor driver will be use to control the dc motor rotation direction.

3) To produce a robot that wills use PIC as the system to generate the data receive from analog output of infra-red sensors become digital and show the result or output using LCD screen.

The analog output from infrared sensor will be connected to the build in ADC inside the PIC18F8550 and 2 pin of RA pin will be define as channel of ADC input.

1.5 THESIS OVERVIEW

This thesis is a combination of 5 chapters that contains the Introduction, Literature Review, Hardware & Software design, Result & Discussion and last is Conclusion.

Chapter 1 is the introduction of the project. The background, objective and the scope of project are explained in this chapter.

Chapter 2 is the literature review that made from several journal that been refer and also consist of the methodologies to done the project.

Chapter 3 is the explanation of hardware and software design of the project. In hardware design , the electronics part and mechanical parts will be explain, the electronic part will be focusing of controller board ,IR sensor ,L293D motor driver and also LCD screen while mechanical parts will explain about the construction of the robot. For software design, the programming of the PIC18F4550 will be explained.

Chapter 4 will show all the results and the analysis of the project. All of the result obtain will be analyzed and the comment will be given due to the result getting.

For chapter 5 the conclusion and discussion will be explain in this chapter.

CHAPTER2

LITERATURE REVIEW

2.0 INTRODUCTION

Conducting literature review prior to begin a research project is vital as this will supply the researcher with much needed additional and information on the methodologies and technology available used by other research counterparts around the world on the topic. This chapter provides a condensed summary of literature reviews on key topics related to types of robot.

2.1 TYPES OF ROBOT

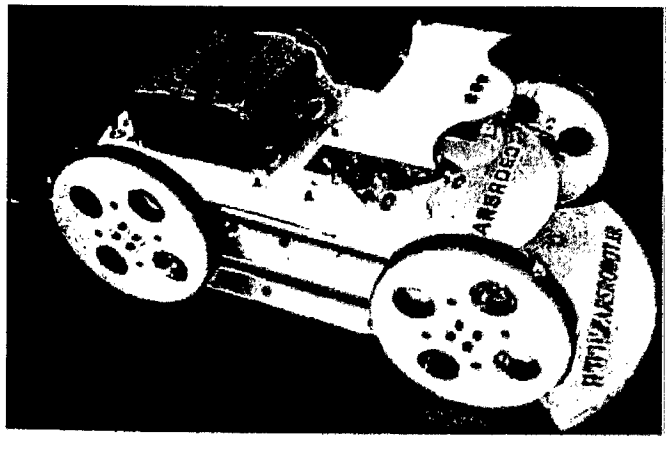

Figure 2.1: Autonomous Minesweeping Robot (Aria)

Aria Robot was a minesweeping robot that designed to use for reduction of the human activities in dangerous environment. Mine detection is a risky action that can be done by either human or robot. Aria Robot is an autonomous four wheels robot that is designed to search through an arbitrary minefield for detecting landmines. Wireless connection is used to established between the local controller on the robot and general controller that is installed at the outside of the minefield to handle the whole navigation procedure. A personal computer (PC) acts as the general controller which is responsible for mapping the landmines and determining some general settings for local controller. The local controller navigates the robot based on the feedbacks from several sensors to detect the barriers and landmines such as digital compass, optical shaft encoder, current sensor, ultrasonic range finder.[5]

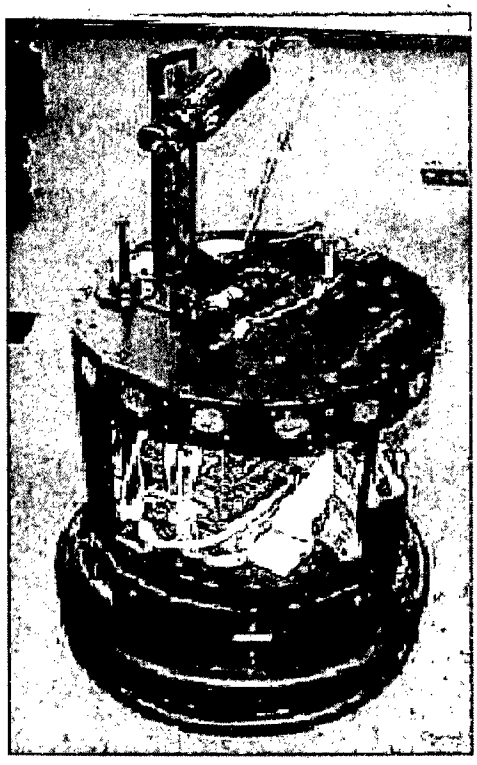

Figure 2.2: The Nomad 200 mobile Robot (Nomadic Technologies, Inc.)

The Nomad 200 has three wheels controlled by two motors. One motor controls the synchronous translation of the three wheels. The other motor enables the three wheels to rotate together. The robot has a turret which, under the control of a third motor, can rotate independently from the base. The robot has a zero turning-radius, it can rotate around its center. Both the steering and drive motors have encoders which enable the measurement and control of both the Cartesian location of the robot, The robot has 16 sonar range sensors, and 16 infrared range sensors. Both types of sensors are equally spaced around the turret. The sonar system uses standard Polaroid transducers, that are based on the usual technique of measuring the time of-flight of an acoustic wave, from emission to reception after being reflected by a detected object. Each sonar sensor is able to measure distances from 15.2 cm to 10.6 m. Each infrared range sensor is composed of one photodiode receiver, placed between two emitters, with all the three elements horizontally disposed. The infrared sensors are used to measure distances to objects less than 60 cm away.[3][4]

2.2 ROBOTIC

Robotics is a revolution of industrial technology. The term of robotics means a different perception and understanding to different people. Some people imagined that robot as Bumble-B and Optirmus Prime from the Transformer movies or others movies characters as real robot should be. But in the reality, robot can be formed in many shape and type as long as it does fulfill the characteristics of robot. The evolution of robotics started in the twenty first century. The 'robot' term was firstly coined in early 1920 by a Czechoslovakian dramatist, Karel Capek in his play entitles "Rossum's universal robots". *Robota* is the original term of robot that widely used since it has been introduced to the public. *Robota* is a czech word which means 'salve laborer'. On 1942 science friction author Isaac Asimov used the term 'robotics' in his short story "Runaround" [1][2].

Traditionally, robots are running in carefully structured environments such as factories, where, while difficult, the designing process of their morphologies and tasks, have been manageable. In the near futures, robots are required to run in highly dynamic and unpredictable environments like in hospitals, homes, schools and streets, often

without human supervisions. Robots increasingly important roles in our daily life,the increase in complexity of the tasks and sometimes physical forms or morphologies of the artifacts consequently requires complex assembling and controlling procedures of them, which soon will be unmanageable by the traditional manufacturing process. [6]

Three Laws of robotics have been introduce in "Runaround" described the three basic of rules that robot should follow to operate without harming or cause injury to , human. The laws are [7][8]:

a) Robot must not injure human

b) A robot must always follow the direction or order given to it by the human being as much as it has not contrast or conflict to first law.

c) A robot must protect its own existence as long as it does not make conflict to first and second law.

The word of robot widely used to describe some electro-mechanical device that is given a set of instruction, which may be partially or fully automated. Robot is defined as a machine that can be programmed in order to accomplish any task provided. Robot Institute of America defines a robot as:

A re-programmable multifunctional manipulator designed to move material, parts,tools, or specialized devices through variable programmed motions for performance of a variety of tasks [6].

Besides the conventional use of industrial robots in industry and the use of fully autonomous robots for collecting samples on other planets (Bares et al. 1989) a new application area for robots has come into being. In these new application fields, humans are the most important factor, who use the robots as partly autonomous or as simply controllable tools.[6]

2.3 PIC CONTROLLER

2.3.1 Microcontroller

Microcontrollers contain at least two primary components – random access memory (RAM), and an instruction set. RAM is a type of internal logic unit that stores information temporarily. RAM contents disappear when the power is turned off. While RAM is used to hold any kind of data, some RAM is specialized, referred to as registers. The instruction set is a list of all commands and their corresponding functions. During operation, the microcontroller will step through a program (the firmware). Each valid instruction set and the matching internal hardware that differentiate one microcontroller from another. [9]

Most microcontrollers also contain read-only memory (ROM), programmable read-only memory (PROM), or erasable programmable read-only memory (EPROM). All of these memories are permanent: they retain what is programmed into them even during loss of power. They are used to store the firmware that tells the microcontroller how to operate. They are also used to store permanent lookup tables. Often these memories do not reside in the microcontroller; instead, they are contained in external ICs, and the instructions are fetched as the microcontroller runs. This enables quick and low-cost updates to the firmware by replacing the ROM.

The number of I/O pins per controllers varies greatly, each I/O pin can be programmed as an input or output (or even switch during the running of a program). The load (current draw) that each pin can drive is usually low. If the output is expected to be a heavy load, then it is essential to use a driver chip or transistor buffer. [9][10]

2.3.2 Types of Microcontroller

Microcontrollers PICmicro MCU from Microchip Company divided into 4 large families. Each family has a variety of components that provide built-in special features:

1. **The first family, PIC10 (10FXXX) - is called Low End.**

The PIC10FXXX devices from Microchip Technology are low-cost, high-performance, 8-bit, fully static, Flash-based CMOS microcontrollers. They employ a RISC architecture with only 33 single-word/ single-cycle instructions. The 12-bit wide instructions are highly symmetrical. The easy-to-use and easy to remember instruction set reduces development time significantly. The PIC10FXXX devices contain an 8-bit ALU and working register.

2. **The second family, PIC12 (PIC12FXXX)– is called Mid-Range.**

The PIC12FXXX most popular among these starter their way in this field. Mid-Range devices feature 14-bit program word architecture and are available in 8 to 64-pin packages that offer an operating voltage range of 1.8-5.5V, small package footprints, interrupt handling, an 8-level hardware stack, multiple A/D channels and EEPROM data memory. Mid-range devices offer a wide range of package options and a wide range of peripheral integration. These devices feature various serial analog and digital peripherals, such as: SPI, I2C™, USART, LCD and A/D converters.

3. **The third family is PIC16(16FXXX)**

With six variants ranging from 3.5K-14 Kbytes of Flash memory, up to 256 bytes of RAM and a mix of peripherals including EUSART, CCP and onboard analog comparators. These devices are well suited for designers with applications that need more code space or I/O than 14-pin variants supply, and are looking to increase system performance and code efficiency by employing hardware motor control and communications capability.

4. The fourth family is PIC 17/18(18FXXX).

The PIC18 family utilizes a 16-bit program word architecture and incorporates an advanced RISC architecture with 32 level-deep stack, 8x8 hardware multiplier, and multiple internal and external interrupts. With the highest performance in Microchip's 8-bit portfolio, the PIC18 family provides up to 16 MIPS and linear memory. PIC18 is the most popular architecture for new 8-bit designs where customers want to program in C language.

Table 2.0 : List of the PIC controller type

PIC #	# of pins	I/O pins	Program ROM words	File RAM bytes	EEPROM bytes	Analogue inputs	Timers 8/16 bits	Max clock (MHz)	Internal osc. (MHz)	In-circuit debug	Serial comms
12F675	8	6	1k	64	128	4x10-bit	1/1	20	4	YES	NO
16F628A	18	16	2k	224	128	NO	2/1	20	4	NO	UART
16F630	14	12	1k	64	128	NO	1/1	20	4	YES	NO
16F648A	18	16	4k	256	256	NO	2/1	20	4	NO	UART
16F676	14	12	1k	64	128	8x10-bit	1/1	20	4	YES	UART
16F73	28	22	4k	192	NO	5x8-bit	2/1	20	NO	NO	ALL
16F77	40	33	8k	368	NO	8x8-bit	2/1	20	NO	NO	ALL
16F818	18	16	1k	128	128	5x10-bit	2/1	20	8	YES	I2C,SPI
16F84	18	13	1k	64	64	NO	1/0	10	NO	NO	NO
16F84A	18	13	1k	64	64	NO	1/0	20	NO	NO	NO
16F88	18	16	4k	368	256	7x10-bit	2/1	20	8	YES	ALL
16F874A	40	33	4k	192	128	8x10-bit	2/1	20	NO	YES	ALL
16F876A	28	22	8k	256	368	5x10-bit	2/1	20	NO	YES	ALL
16F877A	40	33	8k	256	368	8x10-bit	2/1	20	NO	YES	ALL
18F2320	28	25	4k	512	256	10x10-bit	1/3	40	8	YES	ALL
18F6520	64	52	16k	2048	1024	12x10-bit	1/3	40	NO	YES	ALL
18F8621	80	68	32k	3840	1024	16x8-bit	1/3	40	10	YES	I2C,SPI
18F8720	80	68	64k	3840	1024	16x10-bit	1/3	40	NO	YES	ALL

2.4 CONTROL THEORY

Control theory is an interdisciplinary branch of engineering and mathematics that deals with the behavior of dynamical systems .The desired output of a system is called the reference. When one or more output variables of a system need to follow a certain reference over time, a controller manipulates the inputs to a system to obtain the desired effect on the output of the system [11].

If we consider an automobile cruise control, it is design to maintain the speed of the vehicle at a constant speed set by the driver. In this case the system is the vehicle. The vehicle speed is the output and the control is the vehicle throttle which influences the engine torque output. One way to implement cruise control is by locking the throttle at the desired speed but when encounter a hill the vehicle will slow down going up and accelerate going down. In fact, any parameter different than what was assumed at design time will translate into a proportional error in the output velocity, including exact mass of the vehicle, wind resistance, and tire pressure .This type of controller is called an open-loop controller because there is no direct connection between the output of the system (the engine torque) and the actual conditions encountered mean the system does not and cannot compensate for unexpected forces [11].

For a closed-loop control system, a sensor will monitor the vehicle speed and feedback the data to its computer and continuously adjusting its control input or the throttle as needed to ensure the control error to a minimum therefore maintaining the desired speed of the vehicle. Feedback on how the system is actually performing allows the controller (vehicle's on board computer) to dynamically compensate for disturbances to the system, such as changes in slope of the ground or wind speed [11]. An ideal feedback control system cancels out all errors, effectively mitigating the effects of any forces that may or may not arise during operation and producing a response in the system that perfectly matches the user's wishes [11]